Mechano-electrical contribution of ventricular contractions to the complexity of atrial fibrillation electrograms

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Background

- Intracardiac organization indices (OI), such as atrial fibrillation (AF) cycle length, have been used to track the efficiency of stepwise radiofrequency catheter ablation (step-CA) of persistent AF (pers-AF)[1].
- A better understanding of the components and complexity of AF electrograms (EGMs) is fundamental to track the organization of AF during step-CA.
- It remains unknown whether ventricular contractions influence the complexity of AF EGMs by means of mechano-electrical feedback.

Purpose

- Quantification of the potential mechano-electrical contribution of ventricular contractions (VC) on AF complexity.

Methods

Study population

- 6 consecutive patients (61±4 y) with pers-AF (duration of sustained AF 16±10 months) underwent step-CA consisting in pulmonary veins isolation (PVI), defragmentation (CFAEs) and linear ablations as shown in figure 1.
- Study endpoint: termination of AF into sinus rhythm (SR) or atrial tachycardia (AT, figure 1).

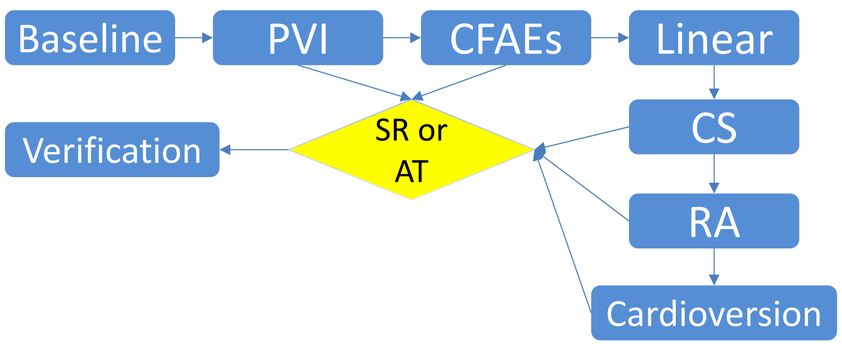

Figure 1: step-CA ablation protocol.

Set-up

- In general anesthesia, four catheters were introduced by the femoral vein. A quadripolar catheter was placed into the right atrial appendage (RAA) for the continuous monitoring of AF EGMs during step-CA.

Signal Processing

- A continuous signal reflecting the RA intracardiac variability (ICV) was computed as shown in figure 2.

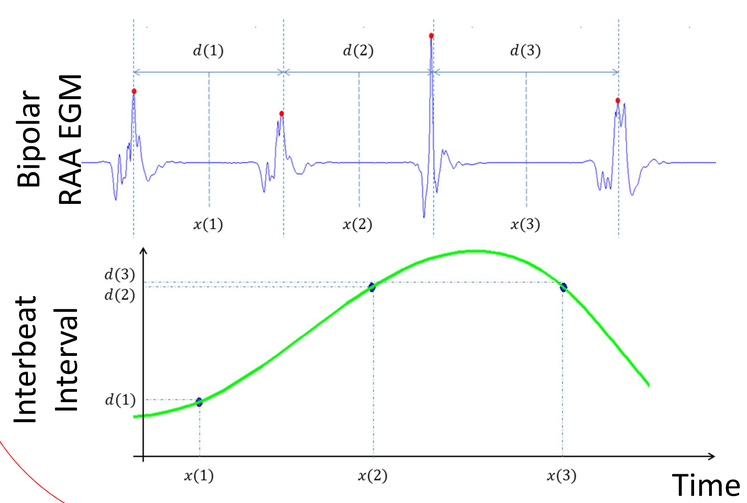

Figure 2: computation of the continuous RAA EGM beat-to-beat variability signal. A robust maximum positive peak detection was applied to RAA EGMs (red dots, top panel). The time difference (*d(i)*) between two adjacent EGM peaks was regularly resampled (green line, bottom panel) in order to generate a continuous signal of RAA beat-to-beat variability.

Methods

Extraction of ventricular contribution to ICV

- The ventricular contribution (VC) to ICV was extracted as shown in figure 3. Lead V_1 was used to identify the ventricular activations (panel A) from which a continuous signal of R-wave impulses was computed (panel B).

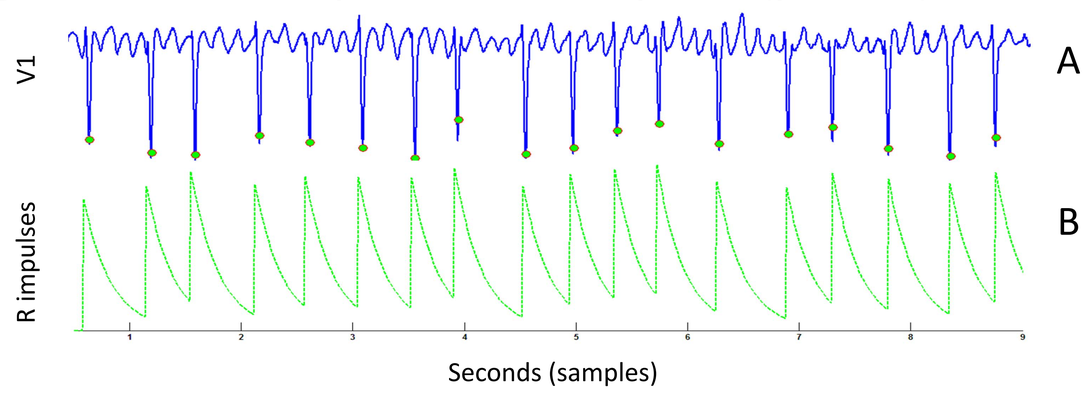

Figure 3: continuous series of R-waves locations.

Cancellation of the VC from the ICV signal

- A continuous ICV signal devoid of the VC contribution was computed using an adaptive interference canceller.

Results

- Step-CA terminated 5/6 pers-AF into SR/AT.
- Figure 4 illustrates the VC contribution at a frequency of 2 Hz (green) to the RAA ICV signal (blue). The ICV signal devoid of VC contribution is shown in red. Note the preservation of all other ICV frequency components (≈ 0.5 Hz and ≈ 1.5 Hz).

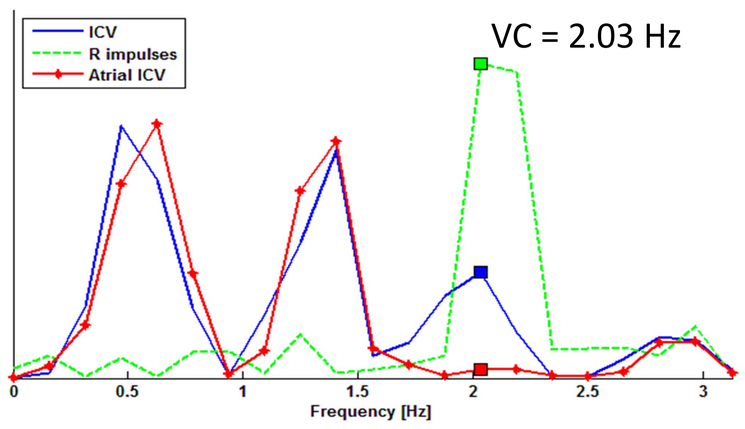

Figure 4: cancellation of VC to ICV.

Overall Study Population

- The mean contribution of the mechano-electrical feedback on the complexity of AF signals as assessed by VC estimation was 37±15%.

Conclusions

- Our results suggest that by means of mechano-electrical feedback, VC contributes up to 37% of EGMs interval variability in pers-AF.
- These preliminary findings are a promising step towards the refinement of organization indices for the titration of ablation during step-CA of pers-AF “en route” to AF termination.

1. Haïsseguerre, Changes in atrial fibrillation cycle length and inducibility during catheter ablation and their relation to outcome - Circulation 2004